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HANDBOOK ON

IMPROVED PEARL MILLET PRODUCTION PRACTICES IN NORTH EASTERN NIGERIA

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Forward and Acknowledgements

This handbook is intended to guide farmers, extension personnel, students of agriculture and researchers in Nigeria to use improved varieties and complementary production practices to increase pearl millet productivity. The guide draws its lessons from the work and experience of ICRISAT and partners in Research for Development on crop-based systems in Nigeria. The publication of this handbook is a demonstration of effective collaboration between ICRISAT, Lake Chad Research Institute, (LCRI) Maiduguri, Federal Ministry of Agriculture and Rural Development (FMARD), several farmer organizations and the demand by Innovation Platform members (IPs) members. ICRISAT and the authors are grateful to the management of these Institutes. The authors gratefully acknowledge the work of other researchers whose work have helped immensely in compiling this manual.

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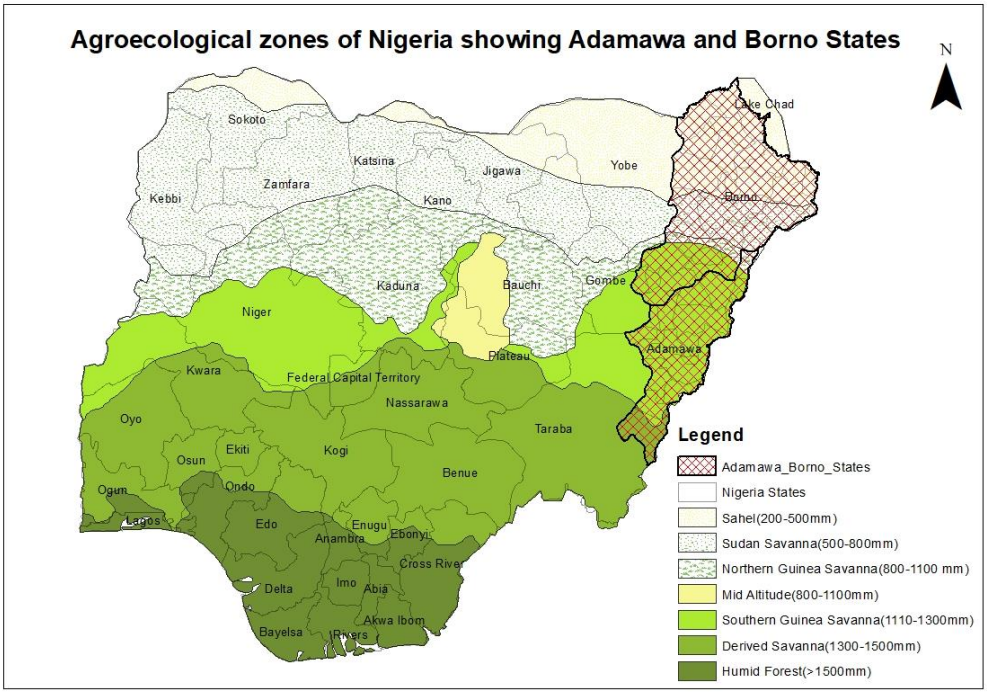
Contents

1. INTRODUCTION

Pearl millet (*Pennisetum glaucum* L. R. Br.), known as *gero/maiwa/dauro* in Hausa language, is a robust, quick-growing cereal grass with large stems and leaves. The plant height ranged from 1.5 to 4.0m it has vigorous growth, with exceptional grain and fodder yielding potential. It is one of the most important dual-purpose crops and a staple food for millions of people in arid and semi-arid ecologies around the world. Pearl millet, commonly called millet, is an important cereal crop mainly grown in the Northern part of Nigeria. The crop thrives well in locations where rainfall does not last long enough to deter its growth. Over 60% and 30% of croplands are devoted to millet in Borno and Adamawa States, respectively. In the north eastern part of Nigeria, millet is largely grown as a rainy season crop, using open-pollinated varieties (local landraces or improved cultivars). It is often grown as a component in intercrops or mixed in cereals-legumes cropping system with crops such as groundnut and cowpea, or with cereals such as sorghum and maize. Due to its superior adaptation (compared to other tropical cereals) to drought, soil salinity, soil acidity, and high temperatures, not to mention its food, feed and fodder values, opportunities exist for millet to make inroads into new niches. This includes the dry season months of March to May when the temperature can rise to 40°C and above.

In terms of its response to day length, pearl millet is usually a short-day plant, but some varieties are day neutral. Due to its general sensitivity to low temperatures, especially at the seedling and flowering stages, it is not cultivated during the cold dry season. However, with the release of day length neutral varieties, it is possible to promote the crop during the post cold dry season between February and June. High daytime temperatures are needed for the grain to mature. It germinates well at soil temperatures of 23-30°C. Emergence occurs in 2 to 4 days under favourable conditions. Although the crop is grown where rainfall ranges from 200-1500 mm, it mostly occurs in areas receiving 250-700 mm. The lowest rainfall areas rely mainly on early-maturing cultivars. Despite its drought resistance, pearl millet requires evenly distributed rainfall during the growing season. Too much rain at flowering causes crop failure. Like most plants, pearl millet does best in light, well-drained loamy soils. The crop tolerates poor, infertile soil better than rice, maize, and sorghum. It performs poorly in clay soils and cannot tolerate waterlogging. It is tolerant of subsoils that are acidic (even those with as low pH (4-5) and high in aluminium content.



2. UTILIZATION

2.1. Household Uses

Pearl millet is a staple food in millions of homes in Nigeria, especially among the poor, mainly in Northern Nigeria. It is also used in making a popular fried cake known as "*masa*". Its flour is used in preparing "*tuwo*", a thick binding paste. It contains 18% protein, rich in vitamin B especially niacin, B6 and folic acid. It is ideal for making flat bread because it lacks gluten. It is an important food across the Sahel States of Borno, Yobe, Jigawa, Katsina, and Sokoto in Nigeria. It is often ground into flour, rolled into large balls, parboiled, liquefied into a watery paste using fermented milk and then consumed as "*fura*" or "*tukura",* a popular beverage in northern Nigeria. Millet is an excellent forage crop because of its low hydrocyanic content. The green fodder is rich in protein, calcium, phosphorus, and other minerals with oxalic acids within safe limits. The glumes and pericarp "*dusa*" are also used in preparing feed for livestock and poultry. The stalks are used in making mulches and as fuelwood. People with celiac disease can replace gluten-containing cereal in their diets with pearl millet. Pearl millet has significant potential as feed and food grain in addition to its current use as forage.

2.2. Nutritional Importance of Pearl millet

Pearl millet is about the most nutritious of the cereal family. On the average, it has higher crude protein content than sorghum, maize, rice and wheat. It contains high amount of dietary fibre, Vitamin B-complex, essential amino and fatty acids and vitamin E. It is high in minerals including iron, magnesium, phosphorous, potassium, zinc, calcium and copper. It also contains foliate and possess phytochemicals that lower cholesterol.

Millet and millet-based food should be promoted first because it is available and produced locally, but more importantly because of the high nutritive value.

3. PRODUCTION PRACTICES

3.1. Pre-planting and planting operations

3.1.1. Site selection:

Millet does well on all soil types including marginal lands, except clayey soils which are subject to waterlogging, adversely affecting plant growth. Sandy loam, well-drained soils rich in organic matter are most suitable for millet production. Fields cropped with legumes (cowpea, groundnut) or sesame in the preceding season are good for the production.

3.1.2. Land preparation:

Millet needs well land prepared by tractor, animal traction or hand hoes. Minimum tillage or conservation tillage plantings can be successful and are desirable on highly erodible land. This will reduce soil erosion, increase moisture retention, and enhance stand establishment owing to better seed depth in firmer soils and the control of weeds prior to planting. Most farmers in northern Nigeria sow directly after the first rain. Land should be prepared well at the onset of rain and ridged at 75 cm running across the slope. If available, 3 to 6 t/ha of farmyard manure (FYM) or compost should be broadcast before ridging. Alternatively, 1-2 t/ha manure applied annually should be fine. Before ridging, farmyard manure can also be applied in old furrow and ridged with animal drawn plough. Manure can also be applied in a ring around each stand at planting or soon after germination, and ridged up later by hand or animal drawn plough to cover the manure.

Figure 1: (L) A well manured field and (R) ridging using a camel in Borno State.

3.1.3. Seed Treatment:

Use any safe, appropriate and approved seed dressing chemical to dress the seeds. Seed dressing has shown about 25% yield advantage, pest and disease control over non-dressing. Use protective clothing and gloves before seed dressing. In a closed container or gourd, shake the seeds with the powder for about 3 minutes or until the seeds are completely covered. Allow the seed dressing chemical to settle before opening the container and bury the empty seed dressing container completely. Wash hands with soap and water immediately after planting.

3.2. Choice of Varieties:

Select varieties suitable for the target location taking into consideration the major biotic and abiotic factors. Some of the available improved varieties are presented in Table 1.

Table 1. Common Released Pearl millet varieties for North Eastern Nigeria					
Common Name	Yield potential (t)	Yield at farmers' fields (t)	Strength	Weakness	Adaptation
SOSAT-C88 (LCICMV-1)	3.0 -3.5	1.5 – 2.0	Resistant to downy mildew, good food taste drought tolerant	Occasional head miner	Sudan
9702 (LCICMV-2)	2.0 -2.5	1.0 -1.5	Medium maturing, stay green good for animal feed, drought tolerant	Occasional head miner	Sudan
SUPER SOSAT (LCICMV-3)	3.5 - 4.0	2.0 - 2.5	High grain yield, resistant to downy mildew, good flour quality	Occasional head miner	Northern Guinea Savanna
JIRANI (LCICMV-4)	2.5 – 3.0	1.0 - 1.8	Early maturing, high Fe and Zn content, resistant to drought	Susceptible to downy mildew, small short panicles, perform best under low moisture content	Sahel

3.3. Planting and Spacing:

Planting should be done as soon as rains are established. Early planting is recommended to escape disease and insect attacks. Farmers in some locations practice dry planting of pearl millet. This is discouraged because early season rains are generally unpredictable; so, the seeds may die in the process of germination. Plant when the soil is moist enough to enable the seed to germinate. Planting can be done either on flat beds or on ridges. The recommended spacing is inter-row spacing of 75 cm and intra-row spacing of 50 cm. Under very low fertility and dry conditions, this can be adjusted to 75 cm by 100 cm and 50 cm by 100cm. Sow 5-8 good quality seeds/hill. Thin to 2 plants/stand after a good rain to avoid seedling competition due to tillering.

Figure 2: Planting of pearl millet.

3.4. Cropping System:

Millet is generally intercropped with legumes like cowpea and groundnut and sometimes with non-leguminous crops like sesame, sorghum, and maize. The cropping pattern varies under the traditional system, from 1:1 alternate row to alternate hill within row as well as several local geometrical arrangements including multiple intercropping that includes more than 2 crops in no defined row arrangement. However, the improved recommended planting system is sole cropping or strip cropping of 2 rows of millet and 4 rows of legume or another crop (Figure 3).

Figure 3: (L) Strip cropping of millet and cowpea and (R) sole cropping.

3.5. Fertilization

3.5.1. Inorganic fertilizer application

In the Sahelian part of Adamawa and Borno States, 80 kg N, 30 kg each of P_2O_5 and K_2O are recommended while 60 kg N, 30 kg each of P and K are recommended in the Sudan and northern Guinea Savannah zones. This can be met by the blanket application of 150-200 kg (3-4 bags) of NPK (15:15:15) at planting or 2 weeks after planting and top dressing with 50-100 kg of urea (2 bags) 4 to 6 weeks after planting. A well fertilized legume crop followed by pearl millet will need less fertilizer application; also, less inorganic fertilizer will be needed if adequate organic fertilizer is applied.

3.5.2. Organic fertilizer application

Organic manures can be used to fertilize millet crop with satisfactory result. Cattle, sheep and goat as well as poultry manure whichever is available should be used. The manure should be broadcasted during land preparation after harrow before ridging. When using cattle manure, 4 -6 t/ha is usually recommended, however because of it bulkiness and scarcity as well as cost, 2-3 t/ha is also accepted. Similarly 2-5 t/ha of poultry manure can be used. Manure has advantage of positive effect on soil improvement properties which include: improve water holding capacity, increase organic material and organic matter content reduce effect of salinity and acidity. It also has longer lasting effect than inorganic fertilizers.

3.5.3. Fertilizer Micro-dosing

Micro-dosing involves the application of small, affordable quantities of fertilizer with the seed at planting time or as top dressing 4 to 5 weeks after emergence. This enhances fertilizer use efficiency compared to spreading fertilizer over the field, and improves productivity. The practice involves burying 1 cork stopper full of NPK 15:15:15 in a 5 cm deep hole 5 to 10 days after emergence. This should be followed by top dressing with 1 cork stopper full of urea 4 to 5 weeks after sowing. Micro-dose can also be done combining organic and inorganic fertilizer or with organic fertilizer alone. A handful (100-200 g) of organic fertilizer (cow/sheep and goat dung) per hill is sufficient. Poultry manure could also be used in place of cow/sheep manure at the rate of 50-100 g/hill. Poultry manure has been found to contain more fertilizer nutrients than ruminant manure.

Figure 4: Micro-dose fertilizer application.

3.6. Weed control

Weeding is necessary to minimize weeds competing for nutrients and to maximize yield. It can be done manually at 3 and 6 weeks after sowing. Animal traction can be used at 6 to 7 weeks after sowing. Pre-emergence herbicide such as Glyphosate as Round up, Delsate, Touchdown etc at the rate of 3.5 L/ha before land preparation can be used. In this case, a gap of 14 days must be given for effective weed control before land preparation. This practice should be followed with 2 hand weeding at 3 to 4-weeks interval to get rid of stubborn weeds like *rottboellia,* sedges, speargrass, and other perennial grasses.

Striga is a parasitic weed and one of the most important challenges in millet production, especially in the drier and less fertile soils of the Sahel and northern Sudan Savannah. The weed is single stemmed with bright red flowers. Most of the damage is done before the parasite emerges from the soil. Farmers are known to sometimes abandon their field if *Striga* incidence is excessive (Figure 5). The symptoms include leaf wilting, leaf rolling, and leaf scorching even though the soil may have sufficient water. The tiny seeds are disseminated by wind, water, and animals, and remain viable in the soil for 15-20 years. Rotation with cotton, groundnut, cowpea and pigeon pea reduces the incidence of *Striga* in sorghum fields. Hand pulling of plants before flowering may help.

Figure 5: An abandoned *Striga*-infested pearl millet field.

3.7. **Pests and Diseases Control**

Damage due to pests such as stem borers can be severe in some seasons. While other pests that attack the crop include head miners (Figure 6), midges, bristle beetle and bugs. Early planting can prevent attacks. Spraying with Cypermethrin and Lambda-Cyhalothrin (karate) can remedy pest attacks. Also, most import disease is the Downy mildew (Figure 7). Destroying cereal crop residues by burning or composting can reduce pest build-up. Birds can severely damage pearl millet; so, bird scaring can serve as a deterrent.

Fighure 6a. Headminer on pearl millet b. Downy mildew disease of millet

3.8. Harvesting

Pearl millet is usually the first cereal to be harvested in the wet season. Early planted millet in the Sudan Savannah zone is harvested in August while late planted millet is harvested in September. In the Sahel zone of north-eastern Nigeria, millet is harvested in September. When millet is mature and ready for harvest, the leaves will turn yellow to brown with the lower leaves drying up completely. To ensure that the grain is mature, pluck out a few grains from the panicle and check the point of attachment. If the tip is brownish black, it signifies that the grain is mature and has no connection with the plant. If it is greenish, then it is still getting nutrients from the plant. Mature grain will be hard and the panicle well filled. Harvest must commence as soon as the crop is mature. In tall and medium-dwarf varieties, the plant is cut down before the panicle(s) is cut off. In dwarf varieties, the panicles are cut off directly from the plant. Harvesting should be done by cutting the stalks and laying them on the field to allow them to dry further (mostly the top of the stalk). It may be tied in bundles and taken to store or threshed. The heads are either allowed to further dry in the field or taken home straight for further drying.

Figure 7: A mature millet crop.

4. POST-HARVEST HANDLING

4.1. Threshing:

Poor post-harvest handling can result in the reduction of quality and yield of millet. Threshing is a process that separates the grain from the heads of millet. It can be done

manually by pilling the millet panicles in a small heap on clean slabs/floor to avoid contamination and beating them with sticks, or using a pistil and mortar or a motorized-multipurpose thresher to ensure quality, reduce drudgery, and save on time.

4.2. Storage:

Mould and germination of grain (sprouts) may occur if grains are not dried properly. It is recommended that the grain be stored at a maximum moisture of 12-13% and be kept in a well-ventilated environment. Several factors lead to the loss of both viability and nutrients, owing to insect, bird, rodent and mould damage. Pearl millet may be stored in the form of tied bundles of heads, but threshing and storing in bags is recommended since the treatment to prevent insect infestation is easier and the space required for storage is reduced.

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ICRISAT HIGHLIGHT

The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) is a non-profit, non-political organization that conducts agricultural research for development in the drylands of Asia and sub-Saharan Africa. Covering 6.5 million square kilometers of land in 55 countries, the semi-arid or dryland tropics has over 2 billion people, and 644 million of these are the poorest of the poor. ICRISAT and its partners help empower these poor people to overcome poverty, hunger and a degraded environment through better agriculture. ICRISAT is headquartered in Hyderabad, Telangana State, in India, with two regional hubs (Nairobi, Kenya and Bamako, Mali) and country offices in Niger, Nigeria, Zimbabwe, Malawi, Ethiopia and Mozambique. ICRISAT conducts research on six highly nutritious drought-tolerant crops: chickpea, pigeon pea, pearl millet, finger millet, sorghum and groundnut. ICRISAT envisions prosperous, food-secure and resilient dryland tropics. To achieve this, its mission is to reduce poverty, hunger, malnutrition and environmental degradation in the dryland tropics. It approaches this through partnership-based international agricultural research for development that embodies *Science with a Human Face*. ICRISAT's strategy is anchored on socio-economic process called inclusive market-oriented development (IMOD). ICRISAT has defined six developmental outcomes that it believes will help the poor to move along the IMOD path: food sufficiency, intensification, diversification, resilience and health & nutrition, and women empowerment. Significant reductions in poverty and increases in food security in the dryland tropics are possible through this route. ICRISAT believes this is the way to meet its inspirational targets of halving the incidence of poverty in smallholder farming households, halving the incidence of hunger, halving childhood malnutrition and significantly increasing the resilience of tropical dryland smallholder farming.